FIBER OPTIC SPLICE COMPONENT HAVING INTERNAL ELECTRODES

FIELD OF THE INVENTION

[001] The present invention relates to a fiber optic splice component and method for fusing optical fibers in the fiber optic splice component. More particularly, the invention is a fiber optic splice component that allows splicing of the optical fibers and sealing of the splice in a single component or a single machine.

BACKGROUND OF THE INVENTION

[002] There are prior art fiber optic splice components and methods for fusion splicing optical fibers and sealing a fiber optic splice. However, the components and methods do not allow for splicing and sealing the splice in a single fiber optic splice component or with a single machine.

[003] Accordingly, the present invention is directed to a fiber optic splice component and machine that substantially obviates one or more of the problems and disadvantages in the prior art. Additional features and advantages of the invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. These objectives and other advantages of the invention will be realized and attained by the fiber optic splice component, machine and method particularly pointed out in the written description and accompanying drawings, as well as the appended claims.

SUMMARY OF THE INVENTION

[004] To achieve these and other advantages and in accordance with the purpose of the invention as embodied and broadly described herein, the invention is directed to a fiber optic splice component that includes a ferrule having a passageway extending from a first end to a second end thereof to hold an optical fiber inserted from each end and having an opening between the first and second ends in communication with the passageway, a housing, the housing configured to hold the ferrule therein, and at least one electrode disposed in the housing and adjacent to the opening in the ferrule for fusion splicing the optical fibers.

[005] In another aspect, the invention provides a ferrule to be used in a fiber optic splice component that includes a body having a first end and a second end, the body having a lead-in portion at the first end and at the second end, a passageway extending from the first end to the second end of the body to hold an optical fiber inserted from each end, and an opening disposed between the first and second ends in communication with the passageway to be used in splicing the optical fibers.

[006] In yet another aspect, the invention provides a method for splicing two optical fibers in a fiber optic splice component that includes the steps of providing the fiber optic splice component, the fiber optic splice component comprising a ferrule having a passageway extending from a first end to a second end to hold an optical fiber inserted from each end and having an opening between the first and second ends in communication with the passageway, a housing, and at least one electrode disposed in the housing adjacent to the opening in the ferrule for fusion splicing the optical fibers, inserting the optical fibers into respective ends of the fiber optic splice component, initiating a fiber optic splice machine, the splice machine applying a voltage to the

electrodes to cause an arc to be generated across the opening of the ferrule thereby fusing the optical fibers, and heating a splice protective element disposed in the housing to melt and form around the fused optical fibers.

[007] In another aspect, the invention provides a fiber optic splice machine that includes a base portion, the base portion including a fiber optic splice holder for holding at least a portion of a fiber optic splice component, electrical contacts adjacent the fiber optic splice holder and in communication with an arc generator, a heating element disposed under the fiber optic splice holder, and a top portion hingedly connected to the base portion and configured to hold a top portion of the fiber optic splice component.

[008] It is to be understood that the foregoing general description and the following detailed description are merely exemplary and explanatory and are included for the purpose of providing further understanding of the invention as claimed.

[009] The accompanying drawings are likewise included to provide a further understanding of the invention and are incorporated in and constitute a part of the specification. The drawings illustrate several embodiments of the invention and together with the written descriptions serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[010] FIG. 1 is an exploded view of an exemplary embodiment of a fiber optic splice component according the present invention;

[011] FIG. 2 is a lateral cross section view of the fiber optic splice component of FIG. 1;

[012] FIG. 3a is a schematic illustration of opposed optical fibers being inserted into the fiber optic splice component of FIG. 1;

[013] FIG. 3b is a schematic illustration of the opposed optical fibers in the area of splicing in the fiber optic splice component of FIG. 1;

[014] FIG. 3c is a schematic illustration of the opposed optical fibers being spliced in the fiber optic splice component of FIG. 1;

[015] FIG. 3d is a schematic illustration showing a splice protection element aligned with the spliced optical fibers;

[016] FIG. 3e is a schematic illustration of the fiber optic splice component after the splicing and sealing operations are performed;

[017] FIG. 4 is an exemplary embodiment of a machine used to splice and protect a fiber optic splice in a fiber optic splice component according the present invention;

[018] FIG. 5 is a lateral cross section view of the machine of FIG. 4; and

[019] FIG. 6 is a partial top view of another exemplary embodiment of a machine to splice and protect a fiber optic splice in a fiber optic splice component according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[020] FIG. 1 illustrates an exemplary embodiment of a fiber optic splice component **10**. The fiber optic splice component **10** is preferably preassembled, with the ferrule **12** already placed in the bottom portion **14a** of the housing. The bottom portion **14a** also retains the strain relief elements **16** on either end of the ferrule **12**. The fiber optic splice component **10** also has a top portion **14b** of the housing with a protection element **20** disposed therein.

[021] The housing is illustrated as having a generally cylindrical configuration. However, the housing could be of any desired configuration, including, for example,

rectangular, oval, etc. The housing preferably made from plastic, but could be made from any appropriate material, including metal. The bottom portion **14a** preferably has two electrodes **22** on either side of the ferrule **12**. The electrodes **22** may be attached to the top edge of the bottom portion **14a** or may be integral with the bottom portion **14a** and protrude inwardly through the housing. The bottom portion **14a** may also have ribs **24a** attached to an outer surface thereof to allow for corresponding structure on the top portion **14b** to assist in joining the bottom portion **14a** with the top portion **14b**. Other methods of joining the two housing portions **14a, 14b** together would also be within the scope of the present invention. Such methods could include a hinge, projections/recesses, etc.

[022] The ferrule **12** is preferably disposed in the bottom portion **14a** prior to use. The ferrule **12** has an opening **26**, preferably near the center (from either end) of the ferrule **12**. The opening **26** allows access to a passageway **28** that extends from a first end **30** to a second end **32** of the ferrule **12**. The opening **26** is large enough to allow the electrodes **22** access to the optical fibers **34, 36** for fusing. As can be seen in FIG. 2, the opening **26** extends slightly more than 180° around the ferrule **12** to fully expose the optical fibers **34, 36** extending from passageway **28**. However, the opening **26** may be greater or less than 180°, depending on the locations of the electrodes **22** and the need to expose the entire circumferences of the optical fibers **34, 36** to the electrical arc generated between the electrodes **22**. The opening **26** need only be sufficient to allow access by the electrodes **22** and the generated arc to the extent necessary to fuse the optical fibers **34, 36**. The ferrule **12** also preferably has a lead-in portion **38** on both the first end **30** and the second end **32**. The lead-in portion is larger at the very end of the ferrule **12** and narrows to about the same diameter as the passageway **28** through the ferrule **12**. The ferrule **12** can be made from thermoset, thermoplastic, or ceramic materials.

[023] The top portion **14b** has a protection element **20** disposed therein. The protection element **20** is typically EVA or some other heat sensitive material that provides similar melt and flow properties. The protection element **20** will be melted and will flow around the fused optical fibers in the ferrule **12** to provide further protection of the splice. The top portion **14b** may also have ribs **24b** as shown in FIG. 2 that engage the corresponding ribs **24a** on the bottom portion **14a**.

[024] The strain relief elements **16** are used to provide strain relief for the optical fibers **34, 36**. While the strain relief elements **16** are illustrated to be frustoconical in shape, they may be of any configuration. However, the strain relief elements **16** preferably function as a lead-in for the optical fibers **34, 36** into ferrule **12**. As illustrated best is FIGS. 3a-3e, the inside diameter of each strain relief element **16** is preferably larger at the end away from the ferrule **12** and is narrower at the end toward the ferrule **12**. While not necessary, the configuration of the strain relief elements **16** is helpful in guiding the optical fibers **34, 36** into the lead-in portion **38** of the ferrule **12**. In fact, the strain relief elements **16** could be cylindrical with constant inner and outer diameters and still be within the scope of the present invention. The strain relief elements **16** preferably have two layers. A first layer **40** made of EVA or other heatable material to provide adhesion around the optical fibers **34, 36** and to hold the second layer **42**. The second layer **42** is a polyolefin that provides abrasion resistance to further protect the optical fibers. The second layer **42** may also provide some moisture protection to the fiber optic splice component **10**. The two layer material for the strain relief elements **16** may be obtained from INSULTAB, Inc. of Woburn, MA.

[025] The fusion of the optical fibers in the fiber optic splice component **10** will now be described with reference to FIGS. 3a-3e. A fiber optic splice component **10** has an

optical fiber **34, 36** inserted from either end. The optical fibers **34, 36** pass through the strain relief elements **16** and into the passageway **28** via the lead-in portions **38** of the ferrule **12**. Eventually, the optical fibers **34, 36** pass into the opening **26**. As illustrated in FIG. 3b, the operator may then advance the optical fibers **34, 36** until they are engaged in the opening **26**. While the ends of the optical fibers **34, 36** are illustrated to be in the center of opening **26**, they need not be located exactly at the center of the opening. However, the closer the optical fibers **34, 36** are to the center of the opening **26** (or wherever the electrodes **22** are located), the better the fusion splice will be. An arc **44**, as illustrated in FIG. 3c, is generated through the electrodes **22**, causing the optical fibers **34, 36** to be fused. After the optical fibers **34, 36** are fused together, as shown in FIG. 3d, the protection element **20** is placed over the fused optical fibers and heated. The melted protection element **20** then flows around the fused optical fibers **34, 36** and fills at least a portion of the opening **26**. At the same time the protection element **20** is being heated, the strain relief elements **16** are also being heated. Since the strain relief elements **16** are preferably made from the same material as the protection element **20**, they too will soften and form around the optical fibers **34, 36** at either end of the fiber optic splice component **10**. It should be noted that the strain relief elements **16** may be moved along the optical fibers **34, 36** to a location that is best suited for the particular application and do not have to be located where illustrated in the figures.

[026] An exemplary embodiment of a machine **50** to splice and heat the fiber optic splice component **10** is illustrated in FIGS. 4 and 5. The machine **50** has a base portion **52** and a top portion **54** preferably connected by a hinge **56**. The base portion **52** has a fiber optic splice holder **58** located therein for receiving a fiber optic splice component, which may be the same as that disclosed above, but may also be of a different

configuration. The fiber optic splice holder **58** has adjacent electrical contacts **60** to engage the electrodes **22** in the fiber optic splice component **10**. The base portion **52** also has an arc generator **62** (FIG. 5) that is in electrical communication with the electrical contacts **60** that engage the electrodes **22** to fuse the optical fibers **34, 36**.

[027] Also present in the base portion **52** is a heating element **64** (FIG. 5). The heating element **64** is preferable disposed directly under the fiber optic splice holder **58** in order to most efficiently heat the fiber optic splice component **10** and thereby melt the protection element **20** and the strain relief elements **16**. Typically the heating element **64** begins heating once the optical fibers **34, 36** have been fused. However, depending on the type of heating element used and the time required for the protection element **20** to come to temperature and the strain relief elements **16** to melt, the heating element **64** may begin heating at the same time or even before the splicing of the optical fibers **34, 36**. The sequence of splicing the optical fibers **34, 36** and heating the fiber optic splice component **10** may be initiated by the operator pressing a button or by simply closing the top portion **54** once the fiber optic splice component **10** is inserted into the machine **50**.

[028] The base portion **52** also has a battery **66** to energize the arc generator **62** and the heating element **64.** The battery **66** is preferably a rechargeable battery that can be recharged in a charger or by a 12VDC source, such as in a vehicle.

[029] The top portion **54** of the machine **50** has an opening **68** therein for receiving the top portion **14b** of the fiber optic splice component **10**. The top portion **14b** can be inserted into and held within the opening **68**, for example by a loose press fit, until an electrical arc is generated between the electrodes **22** of the fiber optic splice component **10** and the optical fibers **34, 36** are fused together. The top portion **14b** can then be removed from the opening **68** and secured to the bottom portion **14a**, as previously

described. Alternatively, the top portion **14b** may be secured to the bottom portion **14a** when the top portion **54** of the machine **50** is rotated about the hinge **56** and closed onto the base portion **52**.

[030] FIG. 6 illustrates another exemplary embodiment of a splice machine **70**, which is similar to the prior embodiment. However, included in this embodiment of machine **70** is a clamping mechanism **72** that holds at least one of the optical fibers **34, 36**. For example, the operator inserts the optical fiber **36** into the clamping mechanism**72**, which closes around the optical fiber **36**. The clamping mechanism **72** then moves relative to the fiber optic splice component **10** and inserts the optical fiber **36** into the opening **26** in the correct location for fusion splicing the two optical fibers **34, 36** together. The clamping mechanism **72** may be moved by virtue of a piezo-driven mechanism in a known manner. However, the clamping mechanism may also be driven by a spring-loaded mechanism. Typically, the clamping mechanism **72** initially inserts the optical fiber **36** into the opening **26** such that a small gap remains between the optical fibers **34, 36** so that the ends of the optical fibers may be cleaned or otherwise processed prior to fusing. The clamping mechanism **72** then operates to move the end of the optical fiber **36** into physical engagement with the end of the optical fiber **34** during the fusing process. However, the clamping mechanism **72** may also operate to insert the optical fiber **36** into the opening **26** such that the ends of the optical fibers **34**, **36** are initially in physical engagement, or are even pre-loaded. Regardless, the clamping mechanism **72** preferably biases the end of the optical fiber **36** against the end of the optical fiber **34** as the optical fibers **34**, **36** are fused together to avoid the formation of any void between the optical fibers.

[031] It will be apparent to those skilled in the art that various modifications and variations can be made in the fiber optic splice component and method for fusing optical fibers of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.